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היחידה למחקר ופיתוח אלקטרואופטי  
ELECTRO - OPTICS RESEARCH & DEVELOPMENT UNIT

## ACOUSTIC SOUNDING SYSTEM FOR LONG RANGE PROPAGATION IN MIDDLE EAST SURROUNDINGS

### First Interim Report

Item 0001



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### First Interim Report

This report briefly describes the design and development activities carried out during the first interim period. The activities concern the two main components of the acoustic field measurement system namely the Acoustic Power Source (APS) and the Acoustic Directive Receiver Antenna (ADRA).

#### 1. The Acoustic Power Source -APS

- 1.1 The APS is designed as a linear array that produces a strong effective acoustic beam in a direction broadside to the array ( $\phi=0$ ). The azimuthal and elevational scans of this beam will be accomplished by mechanically rotating the linear array.
- 1.2 The array is based on standard acoustic sources of the exponential horn type. Following an extensive search, the acoustic horns from Atlas/ Soundolier (USA) were selected based on the acoustic power radiated by these sources in the 40-400Hz spectral region. The maximum power radiated by these horns are in the 125-1000 Hz region.
- 1.3 The APS is designed to be portable and can be positioned in any outdoor location where the atmospheric propagation properties are to be investigated. In accordance with the goals of the current research program the APS is designed to work in the following two modes:

##### 1. The CW mode

In this mode of operation acoustic power will be radiated in 1/3 octave frequency bands. Atmospheric attenuation, wavefront distortion and phase changes for a particular acoustic propagation channel will be studied as a function of frequency. Signal analysis in this mode is based on beamforming.

##### 2. The Burst mode

In order to investigate atmospheric layer structure, wind and turbulence effects on acoustic propagation the APS will work in the modulated acoustic pulse mode. Signal analysis in this mode is based on time domain beamforming and Doppler effects.

## 2     The Acoustic Directive Receiver Antenna (ADRA)

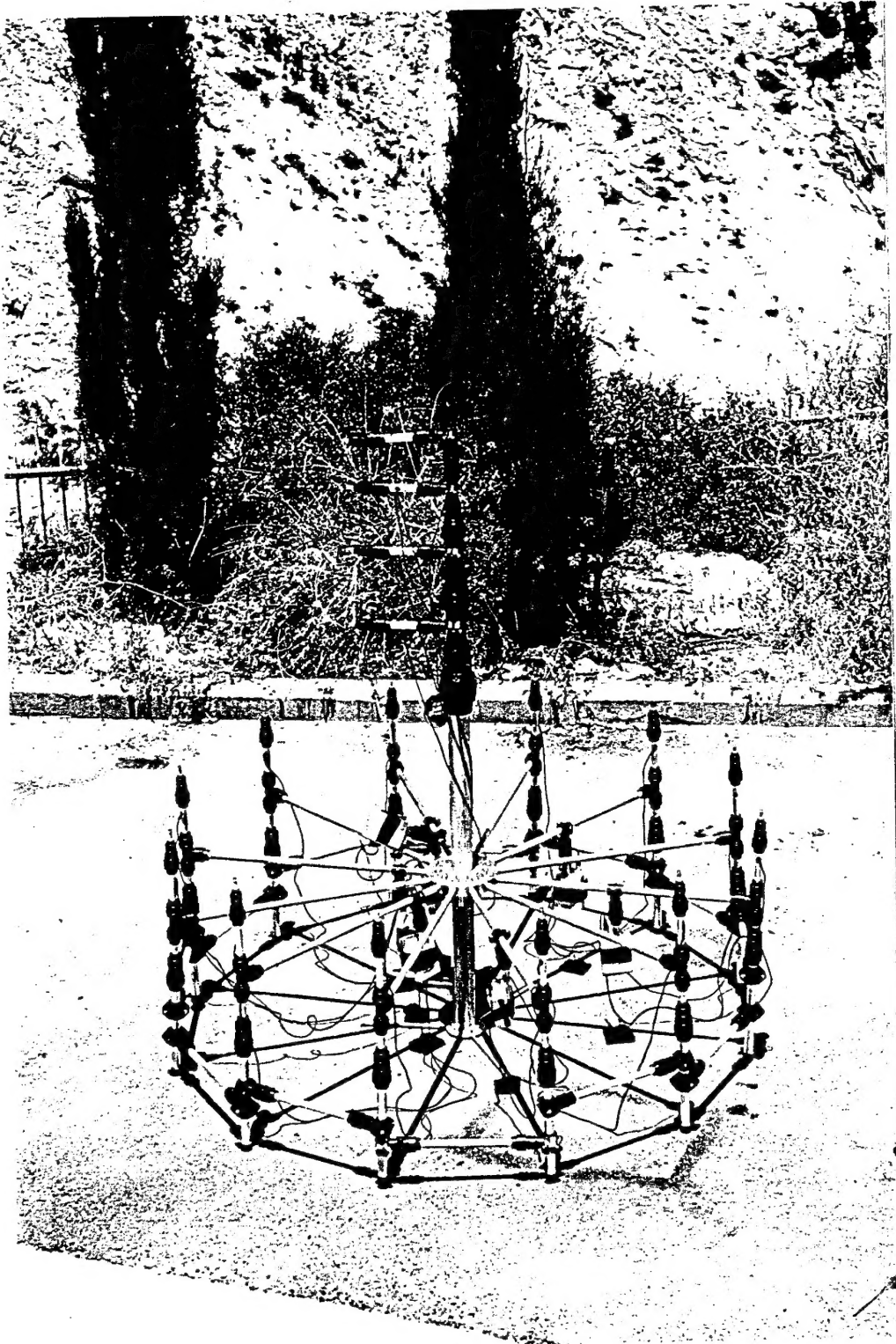
- 2.1   The acoustic antenna consists of a circular array of 12 microphones equally spaced along the circumference. A linear vertical array of 4 microphones projects above the circular plane at its center. This structure enables one to determine the direction of an acoustic source. All microphones used are of measurement quality of type ACO 7046. The antenna is modularly constructed and the dimensions of the circle diameter and the vertical section can be changed from 2m to 8m. In the appendix a picture of the 3-D Acoustic Antenna is included.
- 2.2   The data acquisition and analysis module is based on a PC system and has the following features:
1. Ability to select a segment of raw data from a long recording and for any channel.
  2. FFT and PSD calculations for the selected segment.
  3. Selecting a characteristic frequency and calculating the bearing of the acoustic source based on a multibeam beamforming algorithm.
- 2.3   A typical example of results obtained from a vehicle are given in the Appendix. The appendix includes graphs of the SPL as a function of time, the calculated PSD and a beamformation for two selected frequencies.

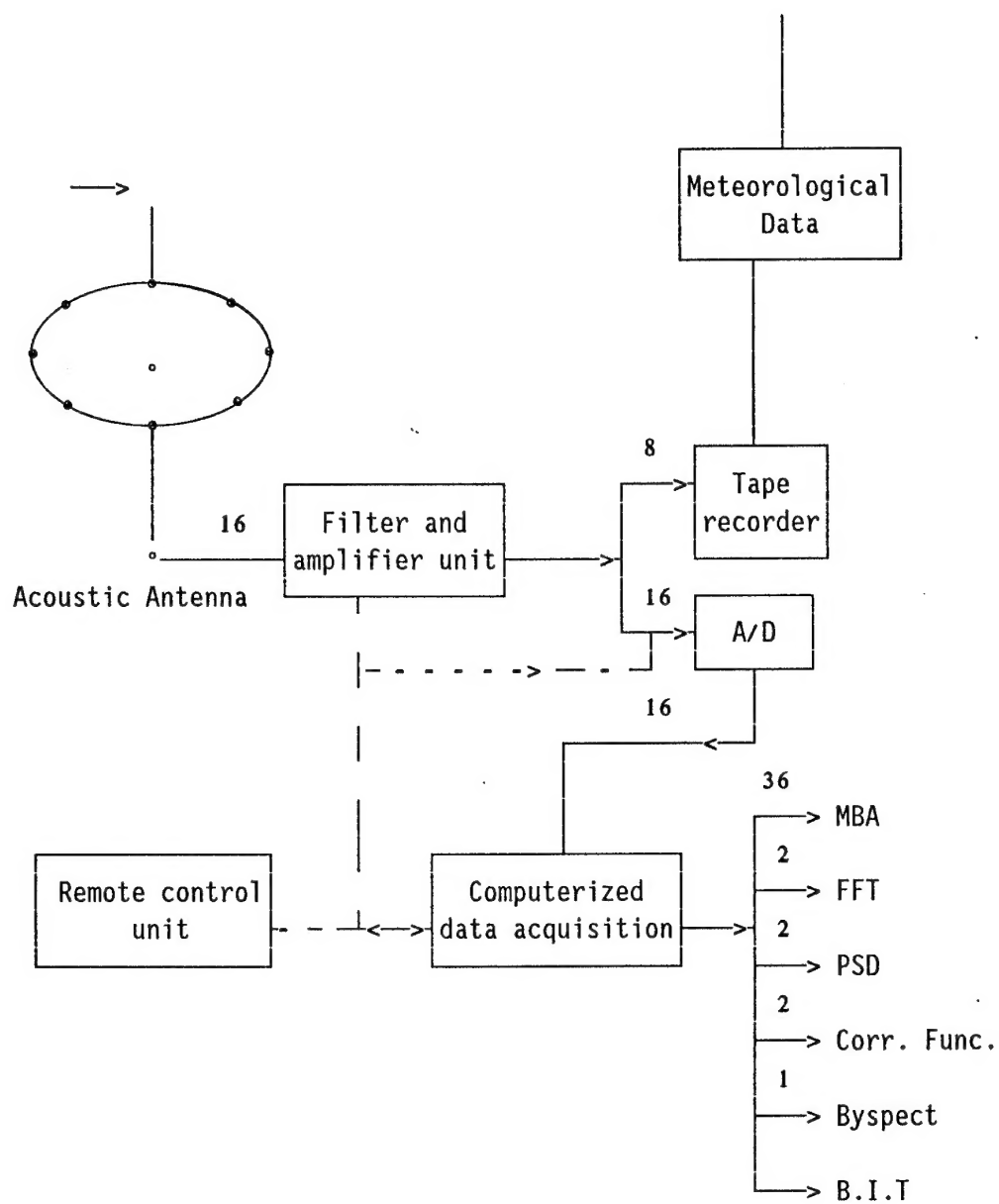
## 3.     The next stages of the research

The following are the main tasks we plan to perform in the next stages of the research:

1. Receiving the APS elements and testing them.
2. Constructing the APS and mapping its radiation pattern.
3. Integration of the ADRA and APS units.
4. Computer simulation of long range acoustic transmission.

## APPENDIX 1

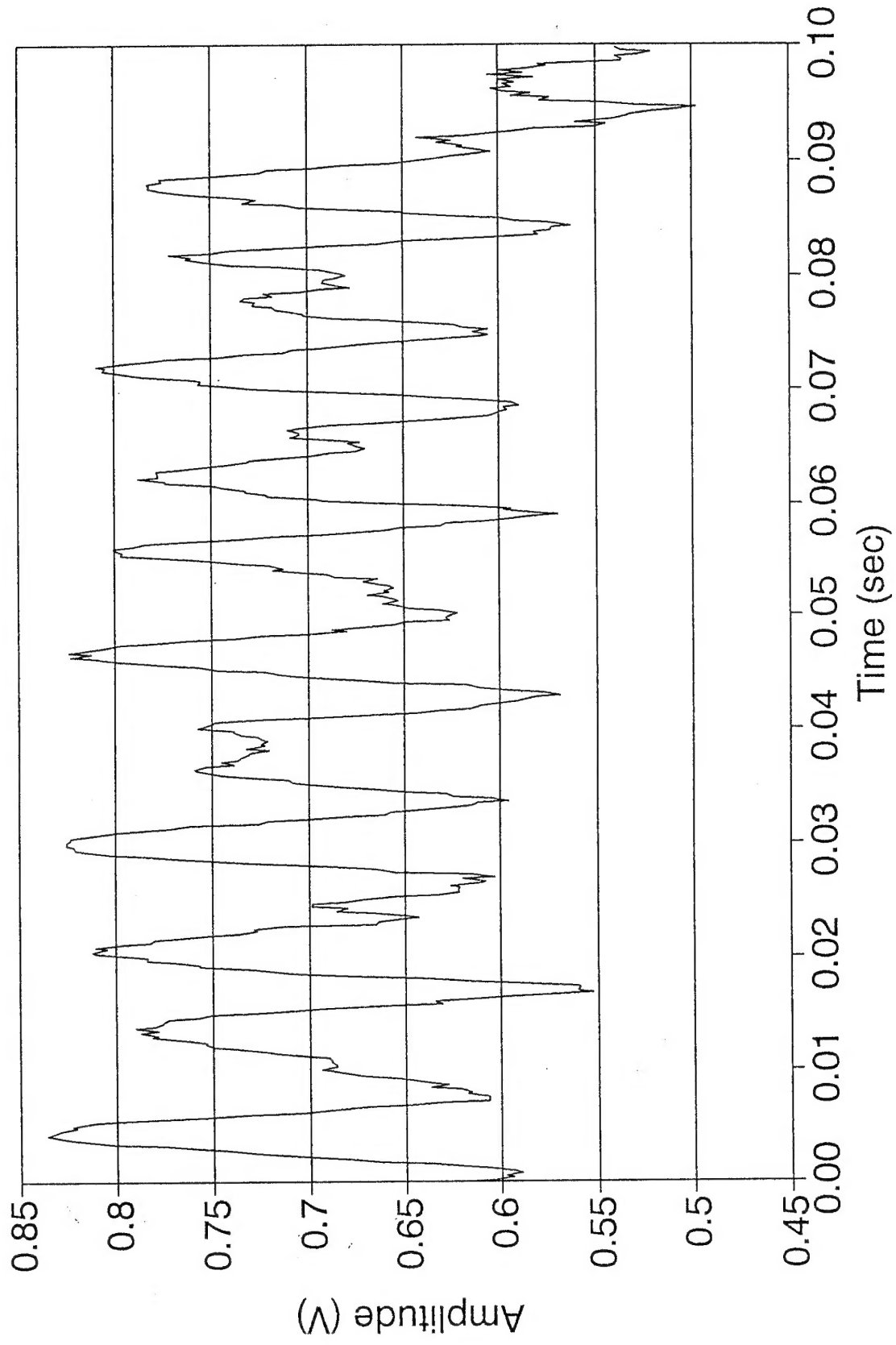




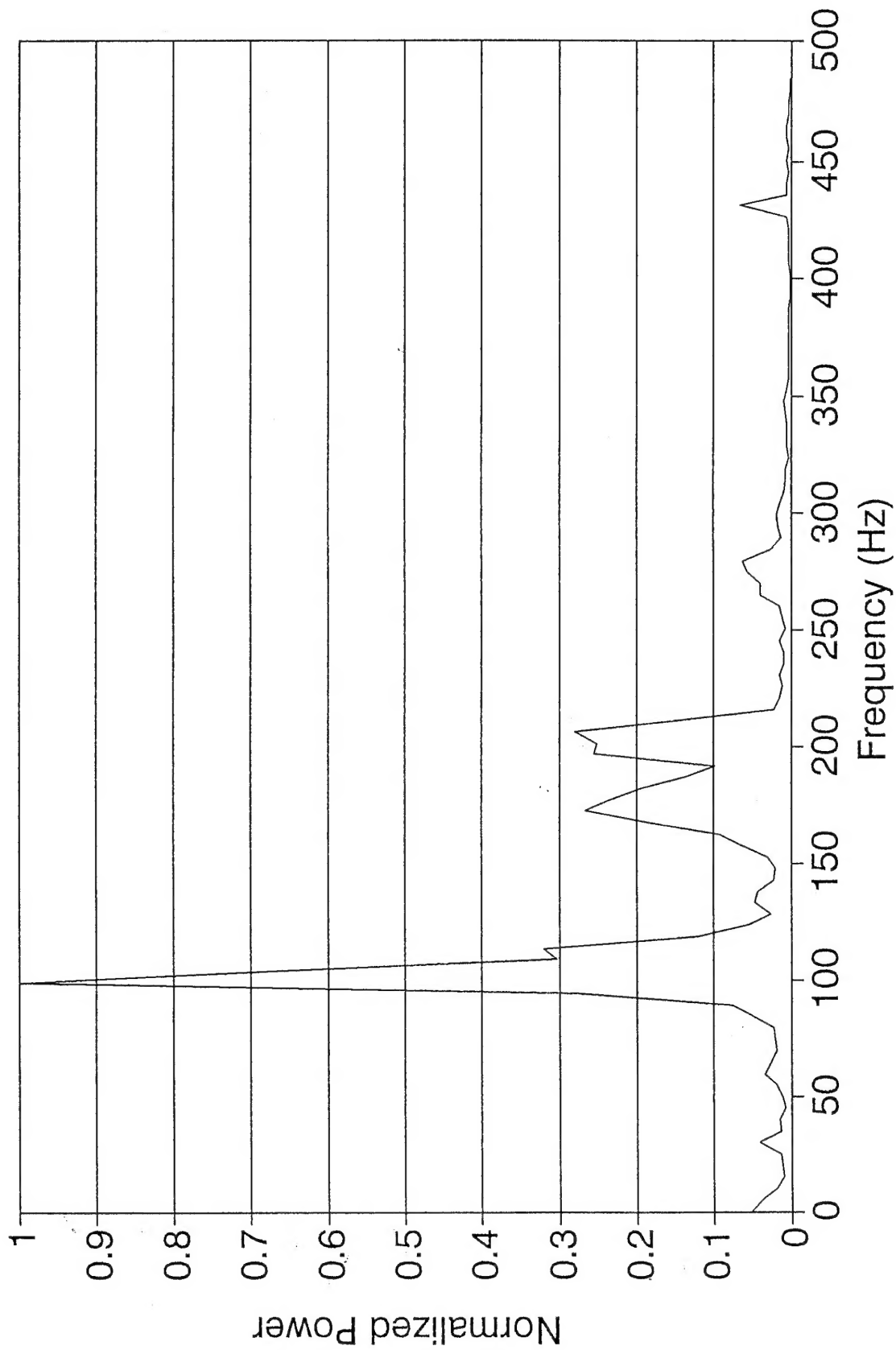
Block diagram of the ADRA



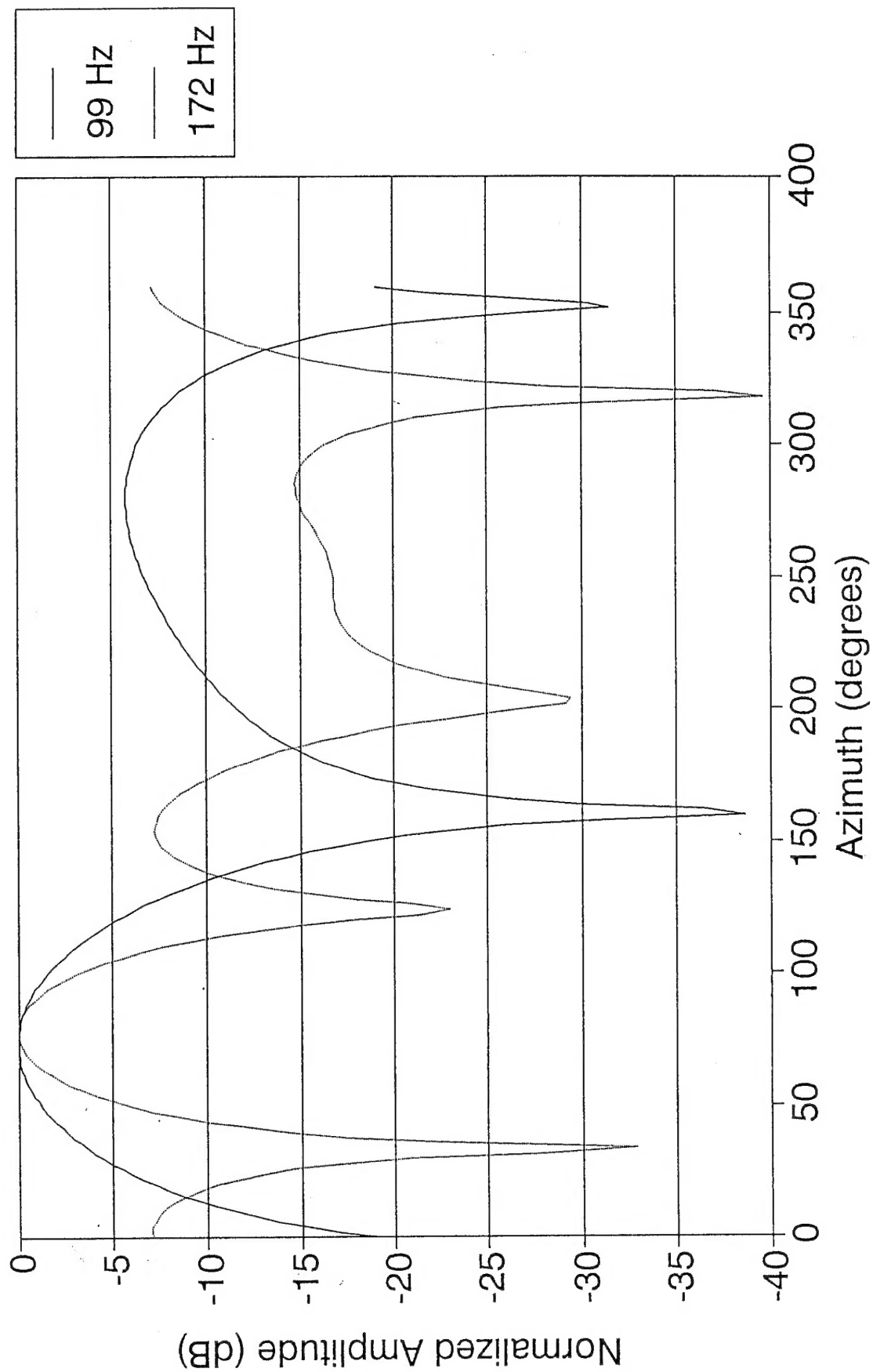
# Raw signal of GMC vehicle



# Power Spectral Density of GMC vehicle



# Acoustical Radiation Pattern



# Acoustical Radiation Pattern

